HE5156H

1.5A 2MHz 5.5V Synchronous Buck Converter

DESCRIPTION

The HE5156H is a high-efficiency, DC to DC step-down switching regulators, capable of delivering up to 1.5A of output current. The device operates from an input voltage range of 2.6V to 5.5V and provides an output voltage from 0.6V to VIN. Working at a fixed frequency of 2MHz allows the use of small external components, such as ceramic input and output caps, as well as small inductors, while still providing low output ripples. This low noise output along with its excellent efficiency achieved by the internal synchronous rectifier, making HE5156H an ideal replacement for large power consuming linear regulators. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal shutdown protection improves design reliability.

The HE5156H is available in SOT23-5,DFN2x2-6 and DFN1.6x1.6-6 package.

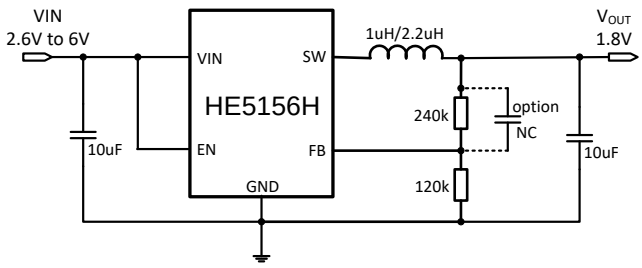
FEATURES

- High efficiency: up to 97%
- Up to 1.5A Max output current
- 2MHz switching frequency
- Low dropout 100% duty operation
- Internal compensation and soft-start
- Current mode control
- Reference 0.6V
- Logic control shutdown (I_Q<1uA)
- Thermal shutdown, UVLO
- Available in SOT23-5, DFN2x2-6, DFN1.6x1.6-6

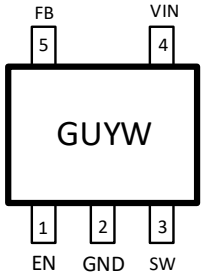
APPLICATIONS

- Cellular phones
- Digital cameras
- MP3 and MP4 players
- Set top boxes
- Wireless and DSL modems
- USB supplied devices in notebooks
- Portable devices

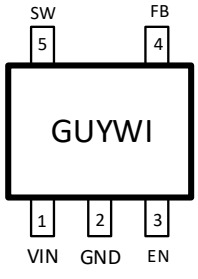
TYPICAL APPLICATION



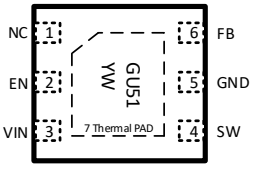
PIN OUT & MARKING



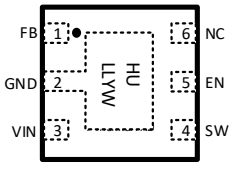
SOT23-5



SOT23-5(B)



DFN2×2-6



DFN1.6×1.6-6

GU/GU51/HU: Product code
LL: Lot No.
YW: Date code (Year & Week)

ORDERING INFORMATION

Part No.	Package	Tape&Reel
HE5156HCB5TR	SOT23-5	3000pcs/reel
HE5156HCB5BTR	SOT23-5	3000pcs/reel
HE5156HCKCTR	DFN2x2-6	3000pcs/reel
HE5156HCKNTR	DFN1.6x1.6-6 [1]	3000pcs/reel
HE5156HCKNTR	DFN1.6x1.6-6 [2]	5000pcs/reel

Note: *1) The DFN1.6x1.6-6 package is packaged in Suzhou Good-ark Electronics Co., Ltd.*
2) The DFN1.6x1.6-6 package is packaged in TRS Microelectronics Co., Ltd.

ABSOLUTE MAXIMUM RATING

Parameter		Value
Max input voltage		8V
Max operating junction temperature(T_J)		125°C
Operating ambient temperature(T_A)		-40°C – 85°C
Maximum power dissipation	SOT23-5	0.6W
	DFN2x2-6	1W
	DFN1.6x1.6-6	0.8W
Package thermal resistance (θ_{JA})	SOT23-5	200°C/W
	DFN2x2-6	80°C/W
	DFN1.6x1.6-6	125°C/W
Package thermal resistance (θ_{JC})	SOT23-5	100°C/W
	DFN2x2-6	18°C/W
	DFN1.6x1.6-6	30°C/W
Storage temperature(T_S)		-40°C - 150°C
Lead temperature & time		260°C, 10S
ESD (HBM)		>2000V

Note: *Exceed these limits to damage to the device. Exposure to absolute maximum rating conditions may affect device reliability.*

ELECTRICAL CHARACTERISTICS

(V_{IN}=5V, T_A=25°C, unless otherwise specified.)

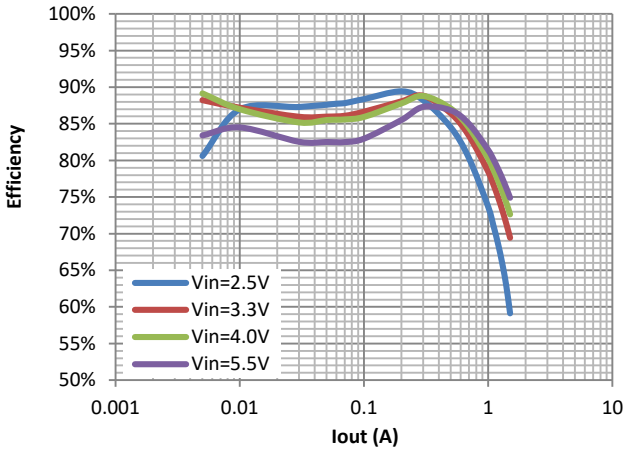
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{IN}	Input voltage range		2.6		5.5	V
V_{OVP}	Input overvoltage threshold			6.1		V
V_{REF}	Feedback voltage	V_{IN}=5V	0.588	0.6	0.612	V
I_{FB}	Feedback leakage current			0.1	1	uA
I_Q	Quiescent current	Active, V_{FB}=0.65, No Switching		80		uA
$I_{SHUTDOWN}$	Shutdown input current	EN=0V			1	uA
LNR	Line regulation	V_{IN}=2.6V to 5.5V		0.1	0.2	%/V
LDR	Load regulation	I_{OUT}=0.01 to 1A		0.1	0.2	%/A
F_{SOC}	Switching frequency			2		MHz
R_{DSON_P}	PMOS R_{DSON}			250	350	mΩ
R_{DSON_N}	NMOS R_{DSON}			150	250	mΩ
V_{UVLO}	Under voltage lockout		1.9	2.1	2.3	V

V_{UVLO_HY}	UVLO hysteresis			100		mV
I_{LIMIT}	Peak current limit			2.3		A
I_{NOLOAD}		V_{IN}=5V, V_{OUT}=3.3V, I_{OUT}=0A		80		uA
I_{SWLK}	SW leakage current	V_{IN}=6V, V_{SW}=0 or 6V, EN=0V			1	uA
I_{ENLK}	EN leakage current				1	uA
T_{SS}	Soft start time			0.3		ms
V_{H_EN}	EN input high voltage		1.2			V
V_{L_EN}	EN input low voltage				0.5	V
T_{SD}	Thermal shutdown temp			160		°C
T_{SH}	Thermal shutdown hysteresis			15		°C

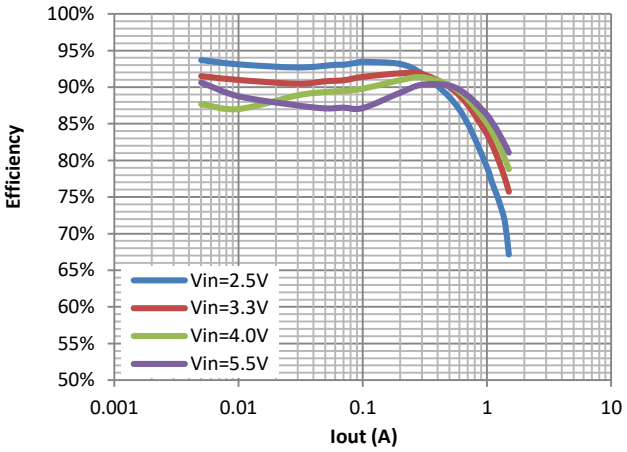
ELECTRICAL PERFORMANCE

Tested under T_A=25°C, unless otherwise specified

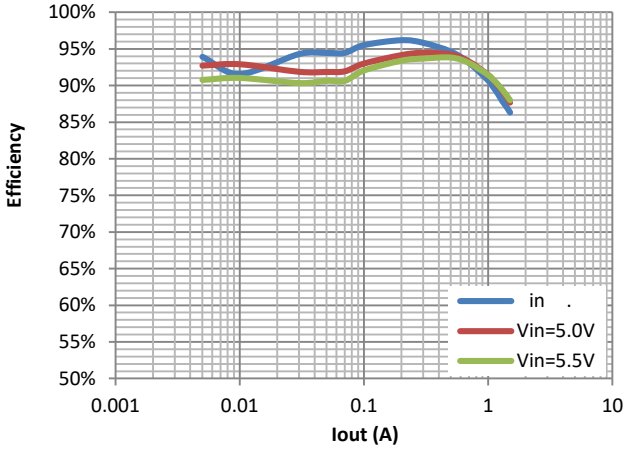
Efficiency vs. Output Current
(Vout=1.2V)



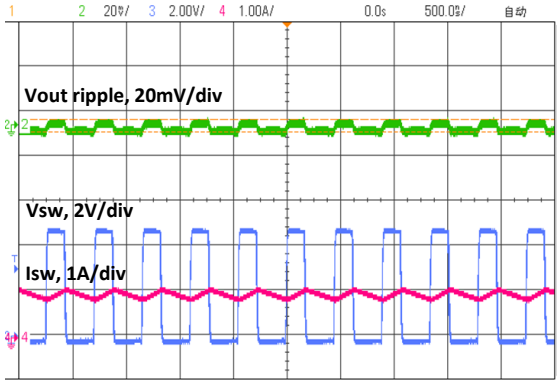
Efficiency vs. Output Current
(Vout=1.8V)



Efficiency vs. Output Current
(Vout=3.3V)



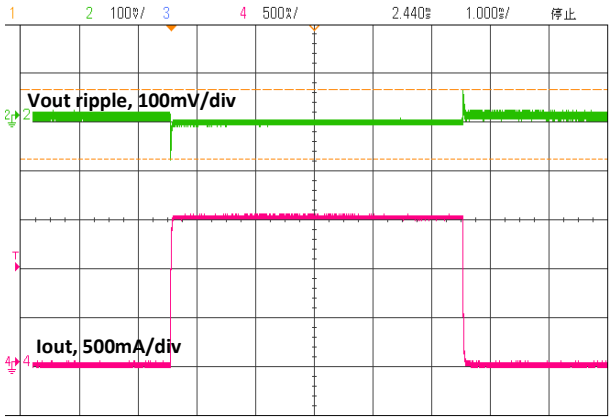
Output Ripple and SW at 1A load
Vin=5V, Vout=1.8V



Ch2—Vout ripple, Ch3—Vsw, Ch4—I_{SW}

Load Transient

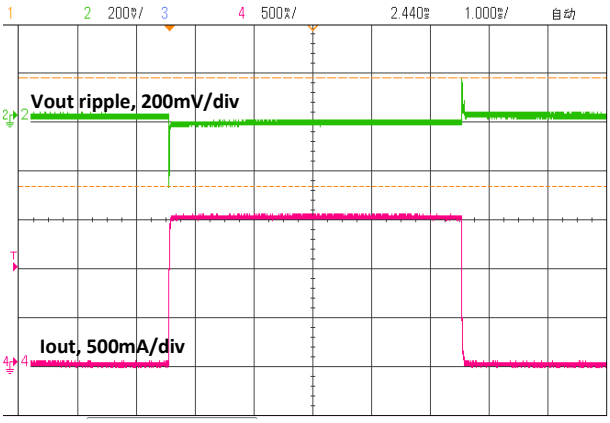
Vin=5V, Vout=1.2V, Iout=0.01~1.5A



Ch2—Vout ripple, Ch4—Iout

Load Transient

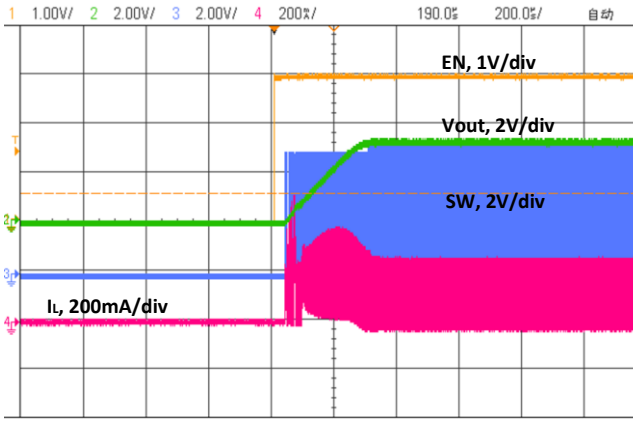
Vin=5V, Vout=3.3V, Iout=0.01~1.5A



Ch2—Vout ripple, Ch4—Iout

EN Power On

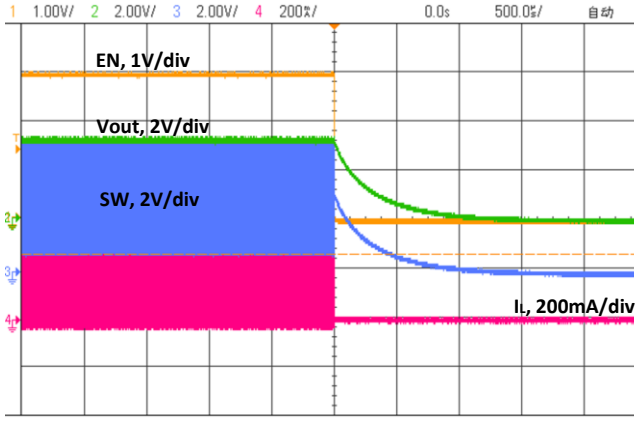
Vin=5V, Vout=3.3V, Iout =0.1A, EN=0V to 3V



Ch1—EN, Ch2—Vout, Ch3—SW, Ch4—IL

EN Power Off

Vin=5V, Vout=3.3V, Iout =0.1A, EN=3V to 0V



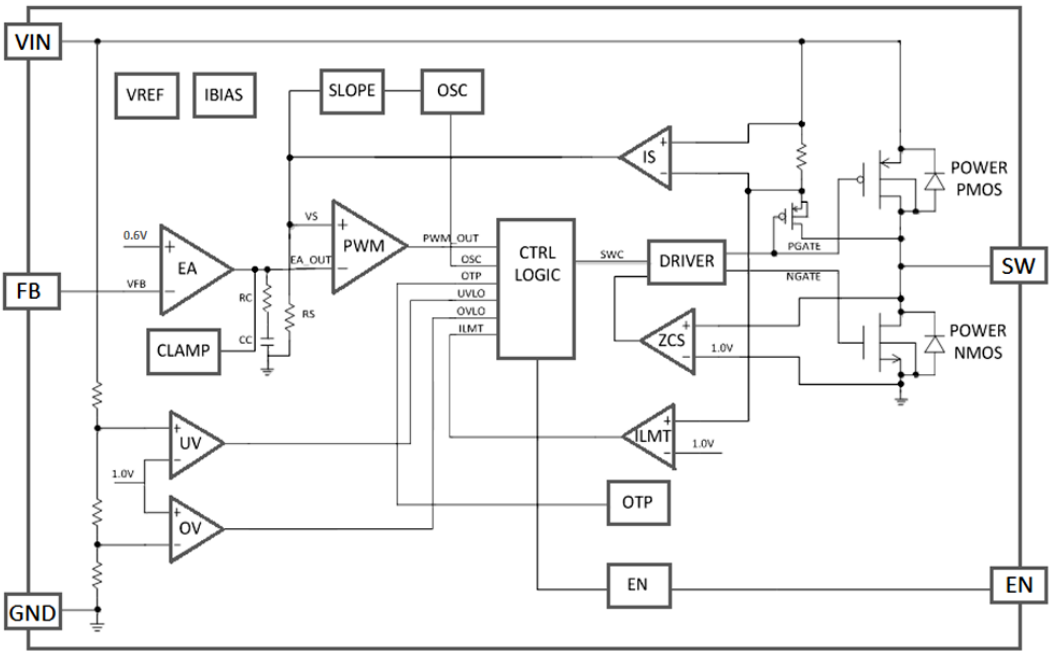
Ch1—EN, Ch2—Vout, Ch3—SW, Ch4—IL

PIN DESCRIPTION

Name	Pin #				Description
	SOT23-5	SOT23-5(B)	DFN2x2-6	DFN1.6x1.6-6	
EN	1	3	2	5	Enable pin for the IC. Drive the pin to high to enable the part, and low to disable.
GND[1]	2	2	5	2	Ground
SW	3	5	4	4	Inductor connection. Connect an inductor between SW and the regulator output.
VIN	4	1	3	3	Supply voltage.
FB	5	4	6	1	Feedback input. Connect an external resistor divider from the output to FB and GND to set the output to a voltage between 0.6V and Vin.
NC	-	-	1	6	No connection.
Thermal PAD	-	-	7	-	Ground

Note: *1) The GND of the DFN1.6x1.6 package is connected to the Thermal PAD.*

BLOCK DIAGRAM



DETAILED DESCRIPTION

The HE5156H high-efficiency switching regulator is asmall, simple, DC-to-DC step-down converter capable of delivering up to 1.5A of output current. The device operates in pulse-width modulation (PWM) at 2MHz from a 2.6V to 5.5V input voltage and provides an output voltage from 0.6V to VIN, making the HE5156H ideal for on-board post-regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

Loop operation

HE5156H uses a PWM current-mode control scheme.An open-loop comparator compares the integratedvoltage-feedbacksignalagainst the sum of the a mplified current-sense signal and the slopecompensation ramp. At each rising edge of theinternal clock, the internal high-side MOSFET turnson until the PWM comparator terminates the on cycle. During this on-time, current ramps up throughthe inductor, sourcing current to the output andstoring energy in the inductor. The current modefeedback system regulates the peak inductor currentas a function of the output voltage error signal.During the off cycle, the internal high-side P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

Current sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error amplifier output by the PWM comparator to terminate the on cycle.

Current limit

There is a cycle-by-cycle current limit on the high-side MOSFET of 2.3A (typ). When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on. HE5156H utilizes a frequency fold-back mode toprevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 100mV, limiting the current to 2.3A (typ) and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

Soft-start

HE5156H has an internal soft-start circuitry to reducesupply inrush current during startup conditions.When the device exits under-voltage lockout (UVLO),shutdown mode, or restarts following a thermalshutdown event, the soft-start circuitry slowly rampsup current available at SW.

UVLO

If VIN drops below 2.1V, the UVLO circuit inhibits switching. Once VIN rises above 2.2V, the UVLO clears, and the soft-start sequence activates.

Thermal shutdown

Thermal shutdown protection limits total power dissipation in the device. When the junction temperature exceeds T_J= +160°C, a thermal sensor forces the device into shutdown, allowing the die to cool. The thermal sensor turns the device on again after the junction temperature cools by 15°C, resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

DESIGN PROCEDURE

Setting output voltages

Output voltages are set by external resistors. The FB threshold is 0.6V.

$$R_{TOP} = R_{BOTTOM} \times \left(\frac{V_{OUT}}{0.6} - 1\right)$$

Input capacitor selection

The input capacitor in a DC-to-DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source. The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance. Output ripple with a ceramic output capacitor is approximately as follows:

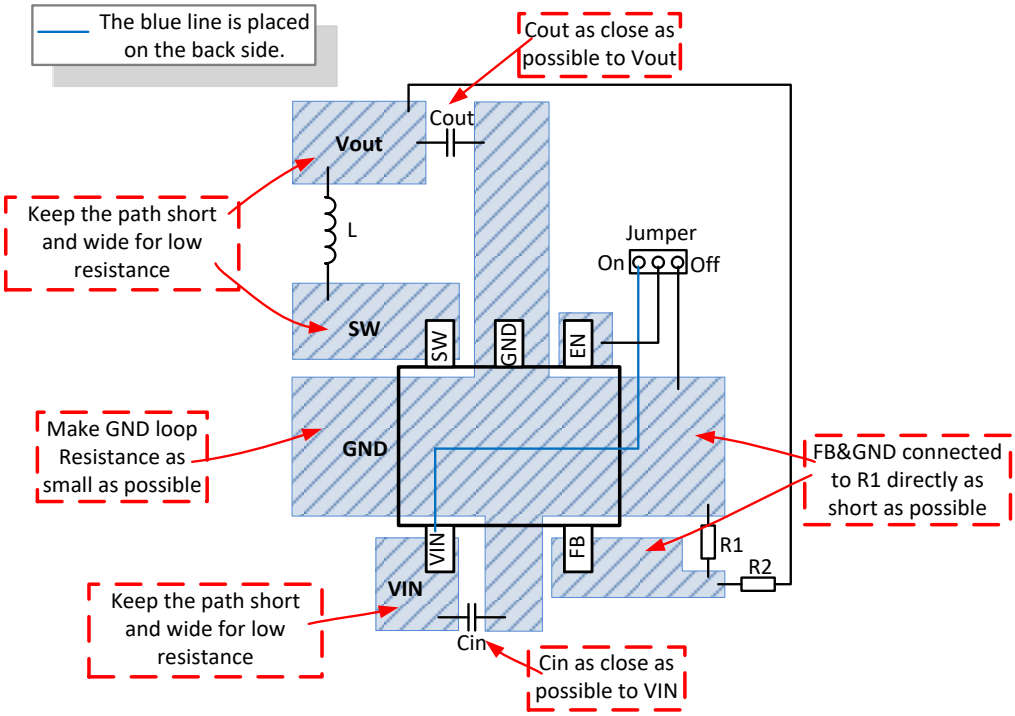
$$\Delta I_L = \frac{V_{OUT}}{L \times f_S} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \times f_S^2 \times L \times C_{OUT}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_S \times L} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right) \times R_{ESR}$$

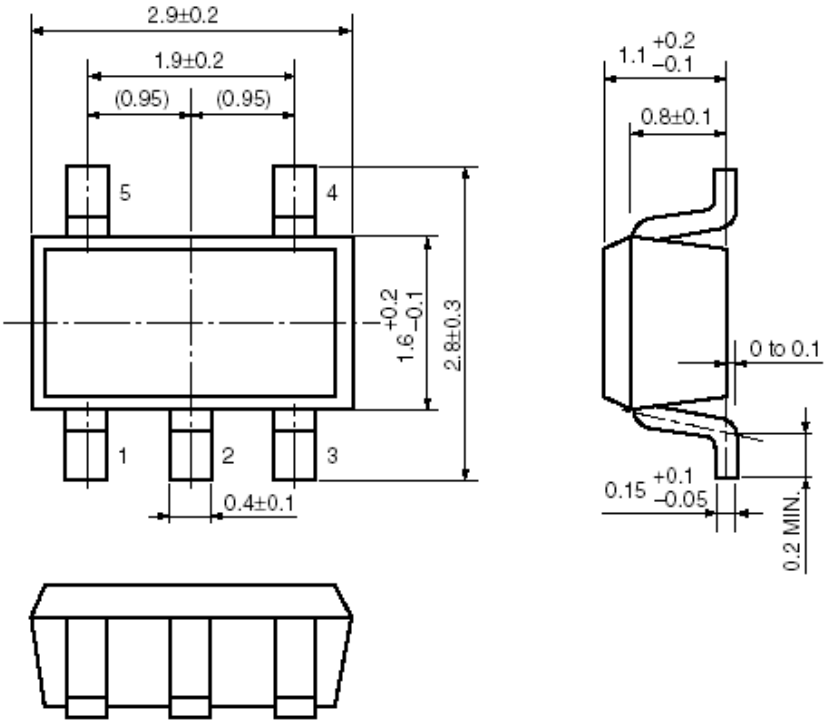
LAYOUT GUIDE



PACKAGE OUTLINE

Package	SOT23-5	Devices per reel	3000pcs

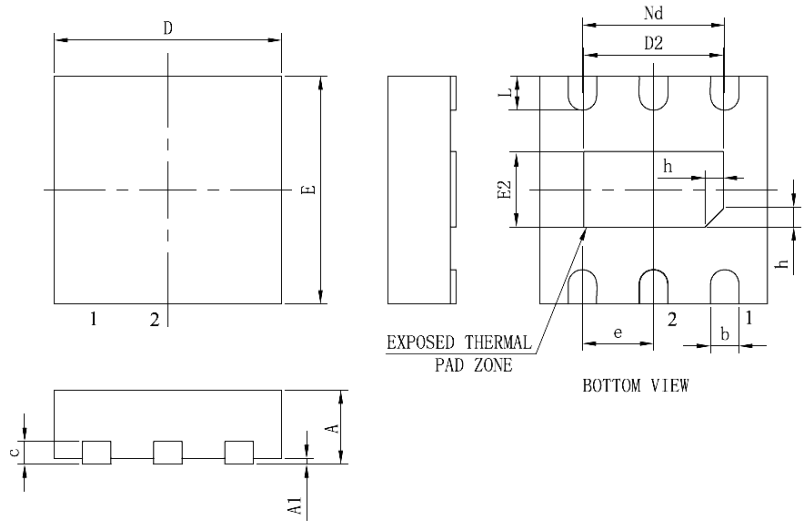
Package specification:



Unit: mm

Package	DFN2x2 -6	Devices per reel	3000Pcs	Vendor	HuaTian Technology(Xi'an) Co., Ltd

Package dimension：

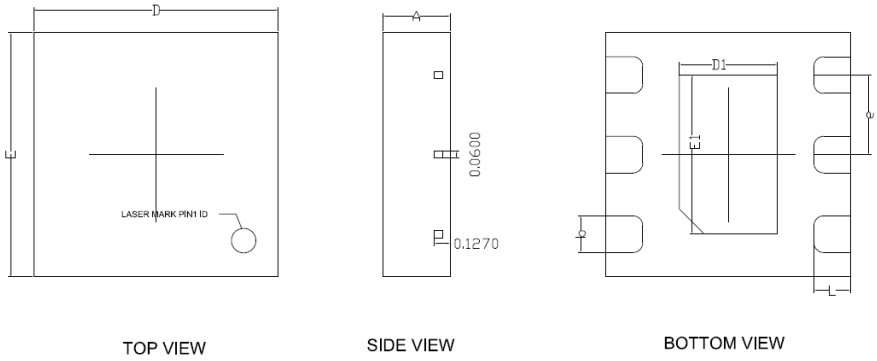


SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	—	0.02	0.05
b	0.25	0.30	0.35
c	0.18	0.20	0.25
D	1.95	2.00	2.05
D2	1.00	1.23	1.45
e	0.65BSC		
Nd	1.30BSC		
E	1.95	2.00	2.05
E2	0.50	0.68	0.85
L	0.25	0.30	0.40
h	0.10	0.15	0.20
载体尺寸（mil）	63*43		

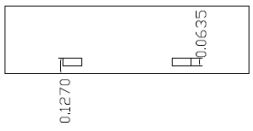
Unit: mm

Package	DFN2x2 -6	Devices per reel	3000Pcs	Vendor	Jiangxi S-core Microelectronics Corp, Ltd

Package dimension：



COMMON DIMENSION(MM)			
SYMBOL	MIN	NOM	MAX
A	0.50	0.55	0.60
b	0.25	0.30	0.35
D	1.90	2.00	2.10
E	1.90	2.00	2.10
D1	1.20	1.30	1.40
E1	0.70	0.80	0.60
e	0.650 REF.		
L	0.25	0.30	0.35

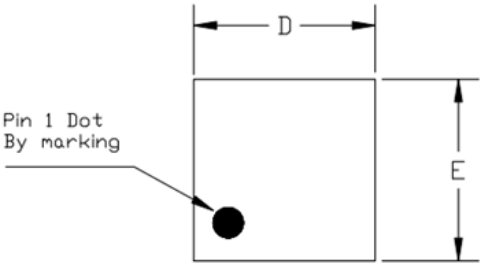


SIDE VIEW

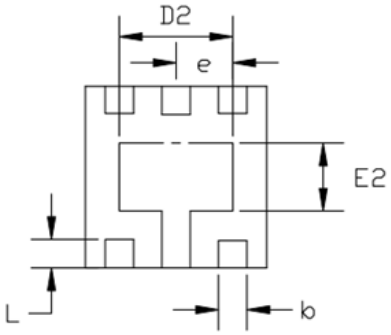
Unit: mm

Package	DFN1.6x1.6 -6	Devices per reel	3000Pcs	Vendor	Suzhou Good-ark Electronics Co., Ltd

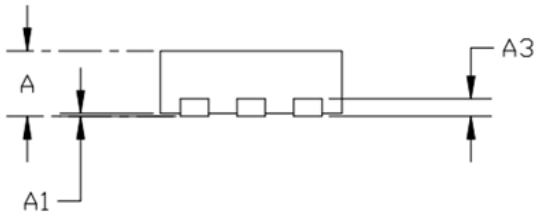
Package dimension：



TOP VIEW



BOTTOM VIEW



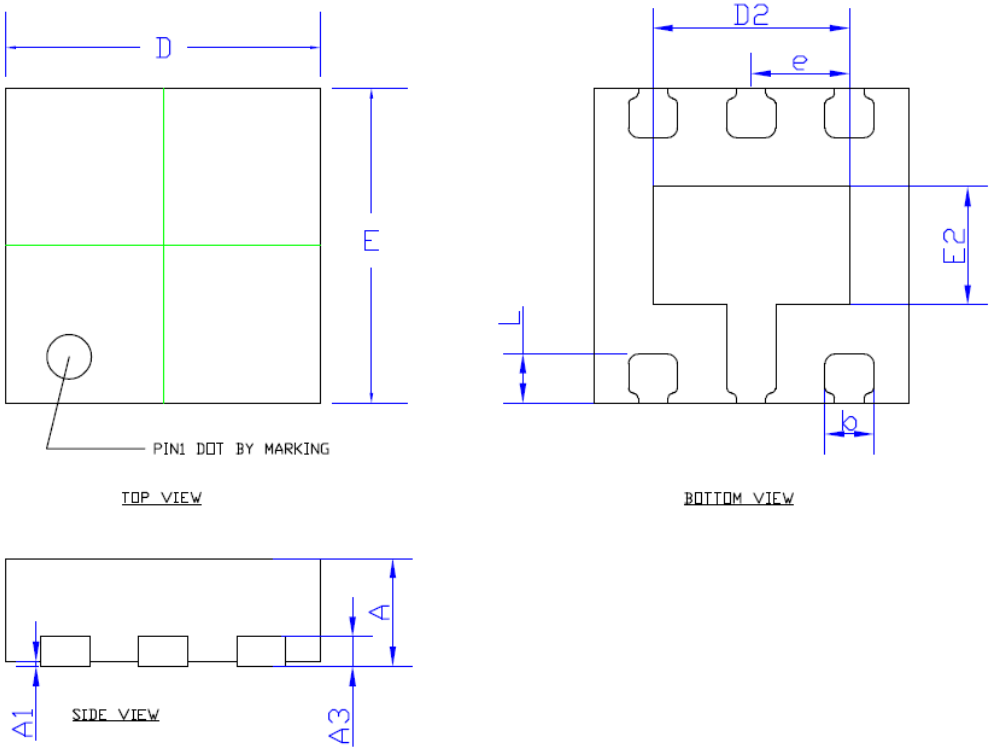
SIDE VIEW

COMMON DIMENSIONS(MM)			
PKG.	UT: ULTRA THIN		
REF.	MIN.	NOM.	MAX
A	0.50	0.55	0.60
A1	0.00	-	0.05
A3	0.15 REF.		
D	1.55	1.60	1.65
E	1.55	1.60	1.65
D2	0.85	1.00	1.10
E2	0.45	0.60	0.70
L	0.20	0.25	0.30
b	0.20	0.25	0.30
e	0.50 BSC		

Unit: mm

Package	DFN1.6x1.6 -6	Devices per reel	5000Pcs	Vendor	TRS Microelectronics Co., Ltd

Package dimension：



Symbol	DIMENSION In Millimeters (MM)			DIMENSION In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.500	0.550	0.600	0.020	0.022	0.024
A3	0.152 REF			0.006 REF		
A1	0.000	--	0.050	0.000	--	0.002
D	1.550	1.600	1.650	0.061	0.063	0.065
E	1.550	1.600	1.650	0.061	0.063	0.065
D2	0.850	1.000	1.100	0.033	0.039	0.043
E2	0.450	0.600	0.700	0.018	0.024	0.028
L	0.200	0.250	0.300	0.008	0.010	0.012
b	0.200	0.250	0.300	0.008	0.010	0.012
e	0.500 BSC			0.020 BSC		

Unit: mm